

*Spectroscopy of Comets*

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***Strategy***

Observations of  $\text{NH}_2$ ,  $[\text{OI}]$ ,  $\text{CH}$ ,  $\text{CO}^+$ ,  $\text{CO}_2^+$ ,  $\text{H}_2\text{O}^+$ , and  $\text{N}_2^+$  in optical spectra of comets represent ionization and dissociation products of virtually all of the volatile fraction of a comet nucleus, and can provide abundances of  $\text{N}_2$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{CH}_4$ ,  $\text{CO}_2$  and  $\text{CO}$ . The primary objectives are to determine: 1) accurate production rates for the observed species, and 2) accurate relative abundances of condensates in a sample of comet nuclei. The ultimate goal is to constrain models of comet formation and chemical processing in the outer primordial solar nebula.

***Progress and Accomplishments***

Monte Carlo models of comet comae have been developed which include effects of multiple-step photodissociation, asymmetric gas flow, radiation pressure, and time-dependent outflow. Improved methods for extracting surface brightness profiles of  $\text{NH}_2$  were developed and used to demonstrate that ammonia production rates can be determined from  $\text{NH}_2$  spectra with relatively insignificant model dependence except in cases of highly active comets. A study of  $\text{NH}_2$  in a diverse sample of comets indicated that the mean ammonia/water abundance ratio was  $\sim 0.1$ , with no significant variation among the comets. The apparent uniformity of the ammonia abundances among comets attests to a remarkable degree of chemical homogeneity over large scales ( $>1\text{AU}$ ) in the comet forming region of the primordial solar nebula. A fluorescence model for the CN B-X band has been developed for determining the  $^{12}\text{C}/^{13}\text{C}$  ratio in a sample of comets.

***Projected Accomplishments***

Calculation of photoabsorption rates of a set of cosmically abundant molecules relevant to comets has been completed using cross sectional data complete to Jan 1991, and a relatively high resolution solar EUV spectrum. The solar rates together with a bibliography will be published. A list of unidentified molecular ion features in the optical region of comet spectra is being compiled. The program to determine the  $\text{NH}_2$  abundances from  $\text{NH}_2$  spectra in an enlarged sample of comets continues. Abundances and the structure of the comet ionosphere are being studied both spectroscopically and with narrow-band images. The  $\text{N}_2^+/\text{CO}^+$  ratio is being used to derive  $\text{N}_2/\text{CO}$  abundance ratios in a sample of comets. Both spectroscopic and narrow-band images of comet Austin are presently being analyzed. The carbon isotope ratios are under study in several comets.

## ***Publications***

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3. Kleine, M. 1990, **Spectral Synthesis of CN in Comets**, in *Workshop on Observations of Recent Comets (1990)*, eds. W. Huebner, P. Wehinger, J. Rahe and I. Konno, (San Antonio: Southwest Research Institute), p. 116.
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